



## Influence of pulsed electromagnetic field on dermatological symptoms of hyperandrogen in obese women with polycystic ovarian syndrome

Influence of pulsed electromagnetic field on dermatological symptoms of hyperandrogen in obese women

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### Abstract

**Aim:** Polycystic ovarian syndrome (PCOS) is common endocrinal problem that leading to irregularity of menstruation, acne, hirsutism, and finally infertility. Low level pulsed electromagnetic field (PEMF) have strong anti-inflammatory effect through restoration of plasma membrane calcium ATPase activity. The purpose of this study was to investigate the effect of PEMF on hyperandrogen symptoms (Acne & Hirsutism) in obese PCOS women. **Material and Method:** Thirty volunteer obese PCOS women were participated in this study, their ages ranged from 20 to 30 years and BMI ranged from 30 to 34.9 kg/m<sup>2</sup>, they randomly divided into two equal groups; group A, which received PEMF three times per week with diet control therapy, group B, which received diet control therapy only. Both groups were evaluated before and after therapy (12weeks) through measuring their weight, C-reactive protein, luteinizing hormone (LH) / follicular stimulating hormone (FSH) ratio, androgen excess symptoms (modified Ferryman–Gallwey (mFG) scoring system & global acne grading system (GAGS)). **Results:** The results of this study showed that there was a statistically significant difference ( $P > 0.05$ ) between both groups (A&B) after therapy (12 weeks) in LH/FSH ratio, CRP, mFG and GAGS, in favor to group (A). **Conclusion** the present study revealed that pulsed electromagnetic field are effective in decreasing hyperandrogen symptoms and improve fertility by improving hormonal variables.

### Keywords

Polycystic Ovarian Syndrome; Pulsed Electromagnetic; Female Sex Hormones; Hyperandrogen

DOI: 10.4328/JCAM.5816 Received: 12.03.2018 Accepted: 15.04.2018 Published Online: 16.04.2018 Printed: 01.11.2018 J Clin Anal Med 2018;9(6): 493-7  
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## Introduction

Polycystic ovary syndrome (PCOS) is the most common complex endocrine disorder affecting approximately 10–15% of reproductive aged females [1]. The incidence of overweight and obesity in PCOS women ranged between 50 and 60% [2]. The prevalence of obesity in the general population is increasing, and this might result in higher incidence of PCOS in the future [3]. Menstrual cycles are dependent on BMI, so ovulation can be highly affected by the increased weight [4]. PCOS Women have hyperandrogenism and insulin resistance (IR), which are associated with reproductive, metabolic, and psychological disorders. Also, the severity of PCOS is more likely experienced with obesity and central obesity compared with healthy women [5].

Also, PCOS is characterized by chronic low-grade inflammation and hyperandrogenemia that lead to metabolic and ovarian dysfunction [6]. The low grade chronic inflammation, reflected in increasing levels of serum C-reactive protein (CRP), which has recently been linked to obesity, insulin resistance, and PCOS [7]. Hyperandrogenism is characterized by excess production of androgens by the ovaries and/ or the adrenal glands. The most common clinical manifestation of hyperandrogenism in women is hirsutism, excessive terminal hair growth in androgen-dependent areas of the body. Other clinical manifestations of hyperandrogenism include acne vulgaris, weight gain, menstrual irregularities, and, in some women with polycystic ovary syndrome (PCOS), acanthosis nigricans [8].

There is increasing interest in the use of pulsed electromagnetic field (PEMF) radiation as an alternative therapy for different medical conditions [9]. Supposing that every cell membrane carries an electromagnetic charge, the application of PEMF leads to movement of ions across the cell membrane. Low level PEMF have strong anti-inflammatory effect through restoration of plasma membrane calcium ATPase activity [10]. So, this study was conducted to examine the effect of Pulsed Electromagnetic Field on hyperandrogen symptoms in obese women with polycystic ovarian syndrome.

## Material and Method

Thirty volunteer obese PCOS women were participated in this study, they diagnosed as having PCOS through ultrasonographic examination, their age ranged from 20 to 30 years old, their BMI ranged from 30 to 34.9kg/m<sup>2</sup>, and randomly divided into two equal groups; group A, which received PEMF three times per week with diet control therapy for 12weeks, group B, which received diet control therapy only.

Individuals with hyperprolactinemia, androgen screening neoplasia, thyroid dysfunction, Cushing's syndrome, ovarian tumor, malignancy, using medication (that affects hypothalamic pituitary ovarian drugs, anti-inflammatory drugs, and weight reduction drugs) and patients with implanted devices were excluded from this study.

- Diagnostic ultrasonography: Medison ultrasound machine, made in Korea, model number Sa8000 EX, serial number A82505300004653, used to confirm the diagnosis of PCOS for all women in both groups A and B before starting the study.

- Weight/height scale: used to measure the weight and height of each patient in both groups A&B before starting the study to calculate their BMI. Weight was measured also after the end of the study.

- Enzyme Linked Immunosorbent Assay (ELISA): micro plate reader (MRX) made in USA with DYNEX technologies, with serial number ICXD3442 and par code number 052100119, used to measure hormones as; luteinizing hormone (LH) and follicular stimulating hormone (FSH).

- Vitros 350 (Ortho Clinical Diagnostic, Inc): made in Rochester, NY14626-5101, and model number ET1529L-7SWA-1-RNBCG, used to measure blood CRP concentration.

- Modified Ferriman-Gallwey scoring system (mFG): used to assess hirsutism.

- The Global Acne Grading System (GAGS): used to assess acne. Treatment instruments: Pulsed electromagnetic field therapy: PEMF machine was applied by health waves generator with two independent channels manufactured by Simed S.r.l. via Machiavelli 10/a, Mogliano Veneto, Italy, serial number 11492, for application of PEMF in all women in group A.

- Evaluative procedure: Diagnostic criteria for selecting PCOS cases in this study were done through Rotterdam Consensus Workshop, in which he stated that PCOS can be diagnosed when 2 of the following 3 features are present: (1) oligo- or anovulation, (2) clinical and/or biochemical signs of hyperandrogenism (ie, hirsutism, acne, male pattern balding, elevated serum androgens), and (3) polycystic ovaries. It is important to exclude other disorders with a similar clinical presentation before a diagnosis of PCOS is made [11].

- Prior to entering the study, all women in both groups apply Ultrasonographic examination to confirm the diagnosis of PCOS through studying the ovarian morphology.

Then, all selected women in both groups A&B underwent the following assessments before starting and after the end of the study

- Weight and height measurements: weight and height of each woman was measured and recorded in the data collecting sheet, and then the BMI was calculated.

- Biochemical assays: blood samples were collected to measure the levels of the woman circulating LH, FSH and CRP.

- Assessment of androgen excess symptoms: it was assessed by the same skilled dermatologist.

- Modified Ferriman-Gallwey (mFG) scoring system: used to assess hirsutism and considered the standard scoring system that defines hirsutism quantitatively [12, 13], in which 9 androgen-sensitive areas of the body were examined. Each area is scored from 0 to 4 depending on the amount of terminal hair growth. A score of 8 or greater indicates the presence of hirsutism. The examined 9 body areas are the lip, chin, chest, upper abdomen, lower abdomen, upper arm, thigh, upper back, and lower back.

- The global acne grading system (GAGS): used to assess acne, this system divides the face, chest and back into seven areas (forehead, each cheek, nose, chin and chest and back) and assigns a factor to each area on the basis of size. The factor of forehead and each cheek was 2, the factor of nose and chin was 1, and the factor of chest and back was 3. Each type of lesion is given a value depending on severity: no lesions = 0, comedones = 1, papules = 2, pustules = 3 and nodules = 4. The score for each area (Local score) is calculated using the formula: Local score = Factor × Grade (0-4). The global score is the sum of local scores, and acne severity was graded using the global score. A score of 1-18 is considered mild; 19-30, moderate; 31-38, severe; and >39, very severe [14].

### Treatment procedure

Diet control therapy: All women in both groups A&B underwent the same diet guidelines therapy during the study period for 12 weeks. This study recommended the hypocaloric diets; followed the literature dietary advice which considered in women with PCOS include high-carbohydrate (55% calories) and low fat (30% of calories) with average protein (15%) [15]. In order to determine the daily caloric requirement of each woman; firstly, the total daily energy requirement for each woman was calculated according to Harris-Benedict formula [16]; [for women:  $BMR = 655 + (9.6 * \text{weight in kg}) + (1.8 * \text{height in cm}) - (4.7 * \text{age in years})$ ], then multiply the result by the activity multiplier (BMR \* 1.2, 1.375, 1.55, 1.725 and 1.9 for sedentary, lightly active, moderately active, very active and extremely active; respectively. Then reduce a 500–1000 kcal/day of the calculated total daily energy requirement. This procedure was repeated in the beginning of each week according to each woman new weight to determine her allowed caloric intake.

Pulsed electromagnetic field treatment sessions: Each woman in group A was asked to lie in the supine position, two plate electrode of magnetotherapy was placed on the lower lateral quadrant of the abdomen (Rt & Lt sides). The total treatment session was 30 minutes divided as follows; the device was adjusted for 5 minutes with frequency 2 Hz and 90% intensity, then 15 minutes with frequency 4 Hz and 100% intensity and finally 10 minutes' random frequency and 80% intensity.

### Statistical analysis

All statistical measures were performed through the Statistical Package for Social Studies (SPSS) version 22 for windows. Prior to final analysis, data were screened for normality assumption, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculation of the analysis of difference and analysis of relationship measures. To determine similarity between the groups at base line, subject age, height and body weight were compared using independent t tests. The current test involved two independent variables. The first one was the (tested group); between subject's factor which had two levels (Group A receiving PEMF therapy in addition to diet control therapy for 12 weeks & Group B receiving diet control therapy only for 12 weeks). The second one was the (training periods); within subject factor which had two levels (pre and post). In addition, this test involved five tested dependent variables (weight, CRP, LH/FSH, hirsutism scale, and Acne scale). Accordingly, 2×2 Mixed design MANOVA was used to compare the tested variables of interest at different tested groups and training periods. The MANOVAs were conducted with the initial alpha level set at 0.05.

### Results

**Baseline and demographic data:** As indicated by the independent t test, there were no statistically significant differences ( $P > 0.05$ ) between subjects in both groups concerning age, weight, and height (Table 1).

Table 1. Demographic characteristics of both groups:

	Group A	Group B	Comparison	
	Mean ± SD	Mean ± SD	t-value	P-value
Age (years)	26.4±3.97	26.86±2.94	-0.365	0.718
Height (m)	1.62±0.061	1.62±0.057	-0.031	0.976
BMI (kg/m <sup>2</sup> )	34.36±1.24	34.12±0.84	0.635	0.530

Statistical analysis using mixed design MANOVA analyzed thirty patients assigned into two equal groups. It revealed that there were significant within subject ( $F = 139.425$ ,  $p = 0.0001$ ) and treatment\*time ( $F = 9.766$ ,  $p = 0.0001$ ) but there were no significant effects between subject ( $F = 2.405$ ,  $p = 0.067$ ). Table (2) present descriptive statistic and multiple pairwise comparison tests (Post hoc tests) for the Weight, CRP, LH/FSH ratio, Hirsutism scale, and Acne scale. In the same context, the multiple pairwise comparison tests revealed that there were significant decreases ( $p < 0.05$ ) in Weight, CRP, LH/FSH ratio, Hirsutism scale, and Acne scale in the post treatment condition compared with the pre treatment one in both groups. Regarding between subject effects multiple pairwise comparisons revealed that there were significant decreases ( $p < 0.05$ ) in CRP, LH/FSH ratio, Hirsutism scale, and Acne scale in group A compared with group B, with no significant differences in weight between both groups ( $p > 0.05$ ).

Table (2): Descriptive statistic and multiple pairwise comparison tests (Post hoc tests) for the Weight, CRP, LH/FSH ratio, Hirsutism scale, and Acne scale for both groups at different measuring periods.

Variables	Group A		Group B		
	Pre	Post	Pre	Post	
Weight	91.33(8.10)	79.06(8.52)	91.2 (5.46)	81.2 (4.49)	
CRP	7.04 (1.65)	2.76 (1.27)	7.04 (1.84)	5.37 (1.52)	
LH/FSH	2.19 (0.26)	1.51 (.2)	2.25 (.34)	1.87 (0.40)	
Hirsutism scale	11.93 (1.27)	8.93 (0.79)	11.86 (1.64)	10.26 (1.03)	
Acne scale	20.06 (3.91)	14.6 (2.32)	20.06 (3.88)	16.8 (2.48)	
Within groups (Pre Vs. post)					
p-value	Weight	CRP	LH/FSH	Hirsutism scale	Acne scale
Group A	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
Group B	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
Between groups (group A Vs. group B)					
p-value	Weight	CRP	LH/FSH	Hirsutism scale	Acne scale
Pre treatment	0.958	0.999	0.591	0.902	0.999
Post treatment	0.398	0.0001*	0.005*	0.0001*	0.018*

\*The mean difference is significant at the alpha level ( $p < 0.05$ ).

### Discussion

This study was conducted to determine the effect of pulsed electromagnetic field on hyperandrogen symptoms in obese women with polycystic ovarian syndrome. We assessed the female weight, LH/FSH ratio, CRP, mFG and GAGS for both the study group; who received PEMF sessions in addition to diet control therapy, and the control group, who received diet control therapy only. The results of this study reveal that there was highly significant difference in all measured parameters

within the groups (pre vs. post measure), while there was highly significant difference between both groups in favor to the study group in LH/FSH ratio, CRP, mFG and GAGS. In this study, women follow the recommended macronutrient composition of weight-loss diets for obese PCOS women include high-carbohydrate (55% calories) and low fat (30% of calories) with average protein (15%) [15]. And the results of the study reveals that there was highly significant decrease in weight in both groups A & B comparing pre and post treatment data, concluded that this type of diet control is beneficial for obese PCOS women.

Weight loss through lifestyle modification before starting fertility treatment is described as the first step for overweight/obese PCOS women who are trying to conceive [17]. Several studies have reported the positive effects of reducing the weight of PCOS women by 5 to 10 percent from her initial weight on improving her hormonal profile and androgen levels [18–20]; which support the results of this study.

In the present study, the application of PEMF for the study group showed improvement in all measured parameter of weight, LH/FSH ratio, CRP, mFG and GAGS. It can be explained by the strong anti-inflammatory effect of PEMF which decreases the CRP and obesity; which in turn improves the hormonal profile of PCOS obese women as LH/FSH ratio and level of androgens which decreases the acne and hirsutism. Pulsed electromagnetic field (PEMF) is an efficient modality used in physical therapy field for treatment of many pathological cases; PEMF has strong analgesic effect, anti-inflammatory effect, and has vasodilatation effect, as well as decreasing edema [21]. PEMF has an electric energy and generates series of magnetic pulses through the tissues, and each magnetic pulse induces a tiny electrical signal that stimulates cellular repair and suppressing inflammatory responses [22].

Many studies [23, 24], reports decrease in CRP levels after exposure to PEMF therapy and after weight reduction program [25]. which supports the results of our study. The application of PEMF therapy in PCOS obese women was not widely introduced, so there was lack of studies to compare their results with the results of the present study, so we can explain the improvements in the study group by the following mechanisms and effects of PEMF; as it can penetrate deep into tissues [26], as it can act at the cellular level affecting different cell function, including cell proliferation and differentiation [27], DNA synthesis [28], RNA transcription [29], protein phosphorylation [30], metabolic activity [31], re-dox mediated rises in the inflammatory transcription nuclear factor kappa B [32], ATP production [33], activation of antioxidant enzyme [34] as well as it can be attenuated to certain vibration frequencies and field strengths in order to stimulate hormones [35].

There are some limitations of this study. Firstly, the lack of follow-up for participants in both groups for several months' post rehabilitation program to evaluate the long lasting effect. Secondly, certain secondary outcome variables such as, functional activity were not assessed. From the results of the present study we could conclude that pulsed electromagnetic field therapy is an effective, safe and non-invasive physical therapy modality which can be added in the protocols of treating obese PCOS women; as it help in decreasing the inflammation noticed in PCOS cases; helping in decreasing weight and CRP which

help in normalizing the hypothalamic pituitary ovarian axis leading to decreasing LH/FSH ratio and decrease androgen secretion which in turn decrease acne and hirsutism.

#### **Scientific Responsibility Statement**

*The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.*

#### **Animal and human rights statement**

*All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.*

#### **Funding: None**

#### **Conflict of interest**

*None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.*

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#### How to cite this article:

Abd Al Samea GA, Mahmoud NF, Hamada HA, Gabr AA. Influence of pulsed electromagnetic field on dermatological symptoms of hyperandrogen in obese women with polycystic ovarian syndrome. *J Clin Anal Med* 2018;9(6): 493-7.